Radio Constructor

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Editorial

ADVANCES in amateur radio technique do not come without some effort and considerable experimentation. And when we do get them, they often have a sting—which may cause us some pain if we do not use them properly. The various forms of V.F.O. which are becoming almost universal in amateur radio stations nowadays are a case in point. The advantages are well enough known to anyone who has used them, but their disadvantages have already earned them considerable disrepute. The bad notes, instability of the poorly designed versions, produced many derogatory remarks when they were first introduced. These troubles have practically disappeared now, with increasing knowledge of how to design V.F.O.'s and greater care in their construction and operation. In fact, some are so stable and reliable that there's a tendency to use them almost as frequency meters and work closer and closer to the edges of the bands with an often misplaced confidence that " you know exactly where you are."

Mr. C. Wright of the Leicester Telecommunications Laboratories' Monitoring Dept., tells us that out-of-the-band operation is becoming so widespread that the authorities are becoming seriously concerned about it. One is often tempted to assume that some amateurs in countries which shall remain nameless do deliberately operate out of the band. But we feel quite confident in saying that no British Amateur is so fool-hardy as to deliberately go out of the band. Those with crystals have no need to worry, but the V.F.O. operators must watch their step when getting near the edge of the bands.

It seems to us that there are three chief causes responsible for getting one out of the band.

The first is that of placing too much confidence in the calibration of one's receiver. Many of the ex-service receivers have rather small bandspread for amateur band work, particularly on the higher frequencies and it is quite impossible to read the band edge calibration with sufficient accuracy to use it as a band edge marker. Even when using a receiver with full band spread, great care must be taken in using it to give one the band limits. So many things can occur rendering its readings unreliable enough for this purpose.

OUT OF THE BAND

The next most common cause is that of calling a station on his own frequency and assuming that he is in the band. Sometimes he isn't! And then the monitoring people put a black mark against a G station as well as against the foreigner!

Finally, there are those people who rely on the calibration of their V.F.O. Well, you may be able to or you may not! It depends on your V.F.O. and the way you built it. Just be careful what you are doing in this respect when you set your V.F.O. right up to the band edge.

If your transmitter is not crystal controlled, you must have an accurate and reliable frequency meter in your station. Maybe we should have devoted still more space to this type of gear. We would have done, had it not been for paper rationing. However, a description of a frequency meter with 100 kcs. sub-standard of an accuracy more than adequate for amateur needs recently appeared in our companion journal the **Short Wave News.*** It should be read by all who are contemplating the construction of a frequency meter.

A.C.G.

(* Vol. 3, No. 5, May, 1948, p. 114).

NOTICES

THE EDITORS invite original contributions on construction of radio subjects. All materia used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will re-draw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

COMPONENT REVIEW. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57, Maida Vale, Paddington, London, W.9. Telephone: CUN. 6579.

Radio Miscellany

By Centre Tap

THE popularity of home construction, instead of proving to be a temporary boom caused by war-time conditions as foretold by people in the industry who should have known better, is certainly increasing. I remember, eighteen years ago how the pessimists gloomily shook their heads and told us the days of home construction, except for a few short-wave fans, were over. True, we shall never again see anything of the same scale of the 1924 to 1930 era, but I cannot envisage a future when home construction will be a lost art. Not only is the hobby wider in scope and more exciting than in the lean years preceding the war, but what a reversal of form! The short-wave fans are all too busy using their ex-W.D. gear to spend much time on construction while the proportion of home-built broadcast receivers continues to rise.

Many constructors feel that the modern BC set is made up with poorer quality components than in 1939 and that there is a depressing "sameness" about all the models for the home market. Purchase Tax, too, gives an added incentive and as plenty of components and valves are available at junk prices, the constructor has the added thrill of knowing the receiver he has built is a "bargain."

This Purchase Tax business seems to be a bit of a puzzle to some correspondents, and in assessing the comparative values or considering fluctuating prices it should be remembered that up to November, 1947, it was 33⅓ per cent. on wholesale prices. With the Emergency Budget it was advanced to 50 per cent., remaining at that figure until April last when it was further increased to 66⅔ per cent. The crippling effect on the home market caused much unemployment throughout the industry so in June the Government had to yield and return to the original figure of 33⅓ per cent., where it seems likely to stay. Even so radio sales are still seriously curtailed as the public, remembering 1939 values, regard them as too costly. The tax may yet have to be removed entirely to keep the industry prosperous, but I have seen too many taxes brought in as a temporary measure, stay indefinitely, to dare to hope for its early removal.

The public's sales resistance is well evidenced by the widely advertised "never-never" terms held out in inducement—a class of business still unnecessary in almost every other trade.

As things are, the constructor gets the satisfaction of not having to pay tax in the purchase of cabinets, speakers, transformers, etc., when sold other than as a part of a receiver. Amplifiers, transmitters and deaf aid valves, of course, have remained untaxed throughout.

Ask Me Another.

The reasons for some of these exemptions from tax are obvious, but I hope no one asks me why some are free. I seem to spend a large part of my life finding possible answers to sticky questions.

Like most other enthusiasts I enjoy trying to help the newcomer, partly because it is in keeping with the fine tradition of our hobby and partly perhaps because it gratifies one of my minor conceits, and anyway, it is the Right Thing. Maybe it was something of this spirit that once again induced me to give a general outline, "From Listening Post to Shack," to a gathering of enthusiasts at a recent meeting. The basis of the idea was gradually building up with gear, not only immediately useful, but with the final aim of equipping a station at the minimum expense. This obviously covers a very wide range and when the time for "Any Questions" came, the youngsters particularly, shot them up by the dozen until I began to wonder whether some were being asked merely to sound my views on a number of debatable subjects. It would have tested the adroitness of a lawyer and the evasiveness of a politician to have answered some of them that touched upon other magazines, writers, radio organisations and proprietary equipment, without risking the rest of my life defending libel suits! Others which were obviously asked by beginners would have required a whole lot of explanation first and even then might not be completely answered.

I did hint that some might be better dealt with by being thrown open to a later meeting for discussion and after hearing all views, form one's own opinion, which will in due course become modified in the light of further experience.

Not a few would seem to be of general interest and here are a few samples. 1—How long should my valves last? 2—What is the simplest way to cut louvres in a steel cabinet? 3—Is it difficult to grind a crystal a few kcs. HF? 4—Why do Mazda have their own size octal bases? 5—Is it true that excessive profits are made on ex-W.D. surplus? 6—Where can I get an American communications receiver properly serviced and aligned? 7—What sort of television picture ought my cousin to get at 150 ft. above sea level, 53 miles from A.P.?

I will try to briefly summarise my replies fully realising that a few readers will disagree with some of them, but that is all to the good. There is nothing like discussion for promoting knowledge.

1—The quick answer might well be about 1,000 hours if operated under correct conditions. Actually the falling off is low initially, but then increases fairly rapidly for a while until finally the rate again slows down. The average valve normally has an exceedingly long useful life and often in actual practice remains in service when its efficiency is a long way down. With the average user it is generally a question of what sort of performance he is content to put up with rather that a question of durability. We all know of cases of receivers in daily use which have not had a valve replaced for years—to the detriment of the set's performance! For most listeners a valve lasts just as long as it gives the results that they demand.

2—As these are formed by heavy presses I frankly cannot think it is possible to cut ventilation louvres in steel cabinets at home or in the " den " type of workshop. It is possible to imitate them in aluminium by deep scoring and beating out with a suitable drift and I have seen a few presentable jobs done this way. Maybe some muscular reader has done this in steel, but I shouldn't care to have to tackle it, preferring the easy course of using holes lined with metal gauze mounted behind them.

3—It certainly isn't easy to do and far less easy to forecast, as some crystals grind more easily than others. There is always the danger of overshooting the mark or the crystal ceasing to oscillate until a bit more grinding is done. I have tackled the job a few times with only about 50 per cent. success. The usual procedure is to use fine carborundum powder on a new carborundum stone or with grinding-in paste on glass. Because of the danger of oscillation ceasing, one face should be marked and that side left severely alone. It is a good plan to cut a rubber or cork disc the size of the crystal, apart from making it easier to handle the pressure is more likely to be evenly spread. The crystal should be washed in warm water or carbon tet. before each test.

4—I just don't know. They started making them that way when the international size was something of a novelty and have kept it up ever since. Perhaps despite what appears at first sight to be the case, it may be good business. I must confess that I used to feel a mild prejudice about it at one time, but after using a few of them (especially the SP61) I just have to put up with it.

5—Very dangerous ground this, as whatever answer I make I am liable to get it where the chicken got the chopper from (a) those who *think* they are, and (b) those who *say* they are not. I have heard it argued very authoritatively both ways and have changed my mind about it half-a-dozen times already. There is, of course, the expense of buying it on speculation as to condition, the transport, sorting, advertising and normal expenses of retailing. There are, too, instances where bulk buyers have got more than their money back on the packing cases alone. The buying price varies enormously—often by hundreds per cent. Prices throughout the trade are more or less uniform so on any one item a dealer may have either a large or very small profit margin by having to fix his price at the general level. As far as I can personally ascertain the average profit is greater than in the retail of new lines, but then the real truth may well be that everybody else's money always looks much more easily come by than one's own.

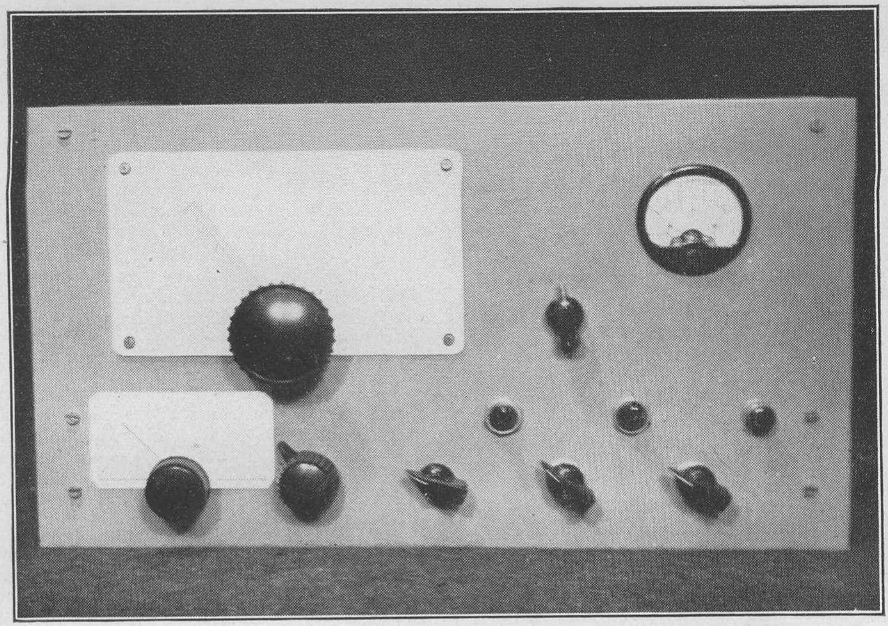
6—Pre-war there were a number of firms specialising in this form of work, but in any case the job is not beyond the capabilities of a competent (and conscientious) radio servicing engineer or advanced amateur having the necessary gear.

7—A good guide is the number (and sort) of TV aerials to be seen in the district—five and six element arrays are by no means unusual on the South coast! Without this as a leader it would seem the cheapest to talk a neighbour into trying it first, was the start to my answer. After the amusement subsided a bright-eyed youngster suggested that the questioner's cousin should get one on the " never-never " and let them take it away if reception wasn't to his satisfaction, but on this happy note the very pleasant meeting had to end. However, the Secretary tells me that he has " dated " me for a future continuation talk when more time could be given over to questions. I am not so thrilled. With the questions thought out beforehand I might find myself on a very sticky wicket.

CO-OPERATION

An application made by the Radio Industry Council to the Minister of Transport to distribute a pamphlet on suppression of ignition interference with television reception upon renewal of motor vehicle licences, was refused. The grounds given were that it was not their policy to allow the " registration machinery " to be used for purposes other than which it was devised.

Despite helpful co-operation from the Post Office and big transport organisations, it still seems to be the aim of our bureaucratic Government Departments to expend their zeal in preventing anybody from doing anything!



An Ac/Dc Short Wave Superhet

R. J. Appleby - I.S.W.L. G988

Describing an Eight-valve communications receiver for 28 - 1·8 Mcs. Amateur Band Operation.

HAVING been for some time a member of the O.V.1 battery " clan," it was decided, although well aware of the capabilities of that type of receiver to attempt something rather more ambitious. There were times when it was thought this was rather a rash move, but the results obtained when completed fully compensated for minor headaches and time spent.

The power supply available being DC it meant either batteries again, vibrators, convertors or an orthodox AC/DC arrangement, and the latter was finally selected. A glance at the circuit diagram shows the receiver to be of fairly conventional design, plus the additions of an 'S' meter used for comparison and/or tuning indicator, and a beat frequency oscillator with variable pitch control. The valves used are: RF Amplifier, EF39; Frequency Changer ECH35; 1st IF and 2nd IF, EF39; 2nd Detector, AVC and 1st Audio Amplifier, EBC33; BFO, EF39; Output, EL32; and CY31 Rectifier. Plug-in coils to cover the five amateur bands in present use between 30 and 1.7 Mcs. with separate RF and Oscillator tuning capacitors are used. The three ganged bandspread capacitors provide a useful amount of spread on the higher frequency bands, approximately 145 degrees and 60 degrees for the 28 and 14 Mcs. bands respectively. Slow motion drives are fitted to the bandspread and main oscillator dials only as the RF main tuning is " flat " enough to be brought into step without any reduction fear.

An IF of 465 kcs. is used, the only apparent drawback with this frequency being a spot of second channel interference from strong signals on the 28 Mcs. band. There are advantages, however, such as extra gain and selectivity when this frequency is used. The lower intermediate frequency is used generally, but this can be changed at will by the use of the separate main oscillator control. In fact, the range covered by any set of coils can be extended by this method.

No RF gain control is fitted mainly because the receiver is used as a " DX trap " only and the more gain obtainable from that stage the better in such a case, so it is left to run " flat out." The frequency changer circuit is practically identical to that recommended by the valve manufacturer so no more need be said about that stage. The 1st IF being the only stage affected by the AVC on/off switch, also carries the meter " bridge " in its anode circuit. A combination of the 2nd IF grid stopper and the IF gain control enables a certain amount of regeneration to take place in this stage, effectively removing a few side bands when needed. In fact, with the gain control at maximum the valve slides into oscillation. Various values of resistance were tried in the stopper position until this condition was obtained and a quarter watt resistor was accommodated in the screened top-cap connector of V4, suitably insulated of course, by a short length of sleeving.

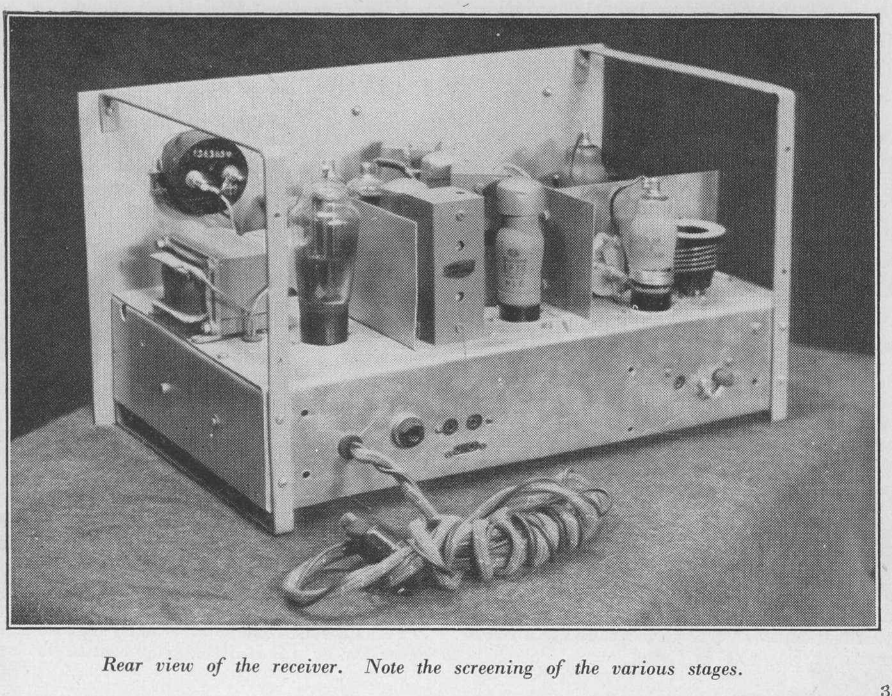
Although a 6in. permanent magnet speaker is generally used, phones can be inserted in the 1st audio stage if necessary by the usual plug and jack method. A simple top-cut control is adjusted by R26.

Power is supplied by the usual AC/DC circuit arrangement and it must be remembered that, in apparatus of this type, the chassis may be alive in respect to earth, which necessitates the introduction of capacitors capable of withstanding at least double the mains voltage in both aerial and earth leads. In the writer's case no earth is used and the aerial in general use being a 28 Mcs. half-wave doublet in the attic terminates in the aerial coupling coil L1, which is effectively insulated from the chassis. The receiver has been tested on AC mains, there being no trace of hum or other " undesirables " apparent.

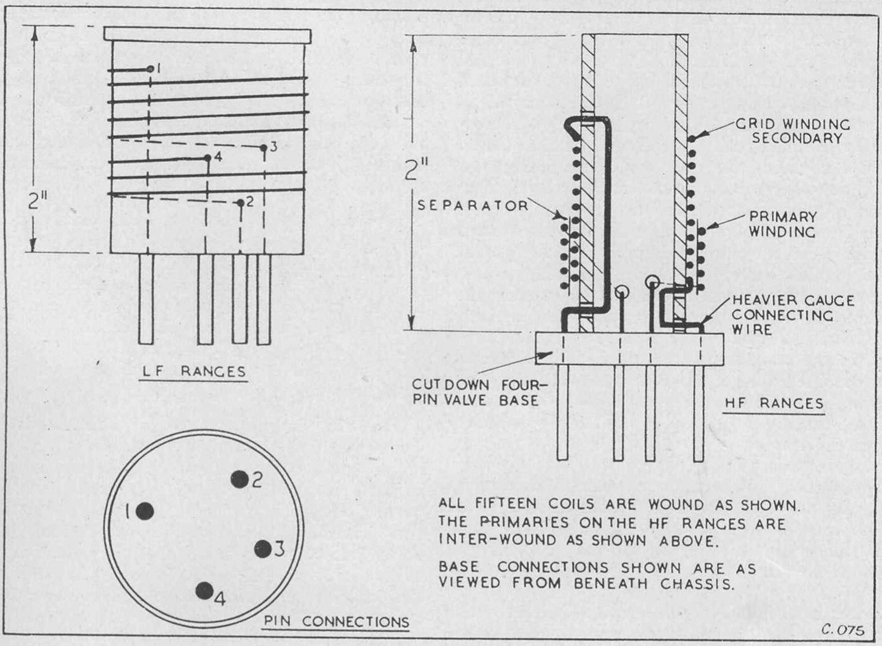
The BFO coil, grid-leak, grid and padding capacitors are all accommodated in a small aluminium can $1\frac{1}{2}$in. x $1\frac{3}{8}$in. x $1\frac{3}{8}$in., the output being coupled to the 2nd detector diode by twisting the lead from the BFO anode for about an inch with a lead from the diode pin. The amount of coupling can be adjusted to suit individual tastes or a suitable small fixed capacitor could be used if preferred.

The coils for the 28 and 14 Mcs. bands are wound on low-loss ribbed formers $1\frac{1}{2}$in. in diameter and for the remainder $\frac{5}{8}$in. paxolin tube is used attached to cut-down four-pin valve bases. The diagram gives details of method and windings, etc. Suitable coil bases and valve holders in ceramic or similar material are used for L1/2, L3/4, L5/6 and V1 and V2. This is to be recommended if the receiver is to be used on the higher frequency bands as is the case here.

The meter circuit adjustments were made when everything else had been " battened down."



Rear view of the receiver. Note the screening of the various stages.



COIL WINDING DATA

28 Mcs., $1\frac{1}{2}$in. former, 18 swg, Tinned Copper Wire.

L1, 3, 5—3 turns spaced own diameter.

L2, 4, 6—$2\frac{1}{2}$ „ „ „ „

Distance between windings, 1 dia. of wire.

14 Mcs. $1\frac{1}{2}$in. former, 22 swg Tinned Copper Wire.

L1, 3, 5—$3\frac{1}{4}$ turns, spaced own diameter.

L2, 4, 6—$4\frac{3}{4}$ „ „ „ „

Distance between windings, $\frac{1}{8}$in.

7 Mcs. $\frac{5}{8}$in. former.

L1, 3, 5—6 turns 40 swg E&SSC close wound over earthy end of secondary.

L2, 4, 6—22 turns close wound, 26 swg enamelled.

3.5 Mcs. $\frac{5}{8}$in. former, 40 swg E&SSC.

L1, 3, 5—15 turns close wound over earthy end of secondary.

L2, 4, 6—60 turns close wound.

1.7 Mcs. $\frac{5}{8}$in. former, 40 swg E&SSC.

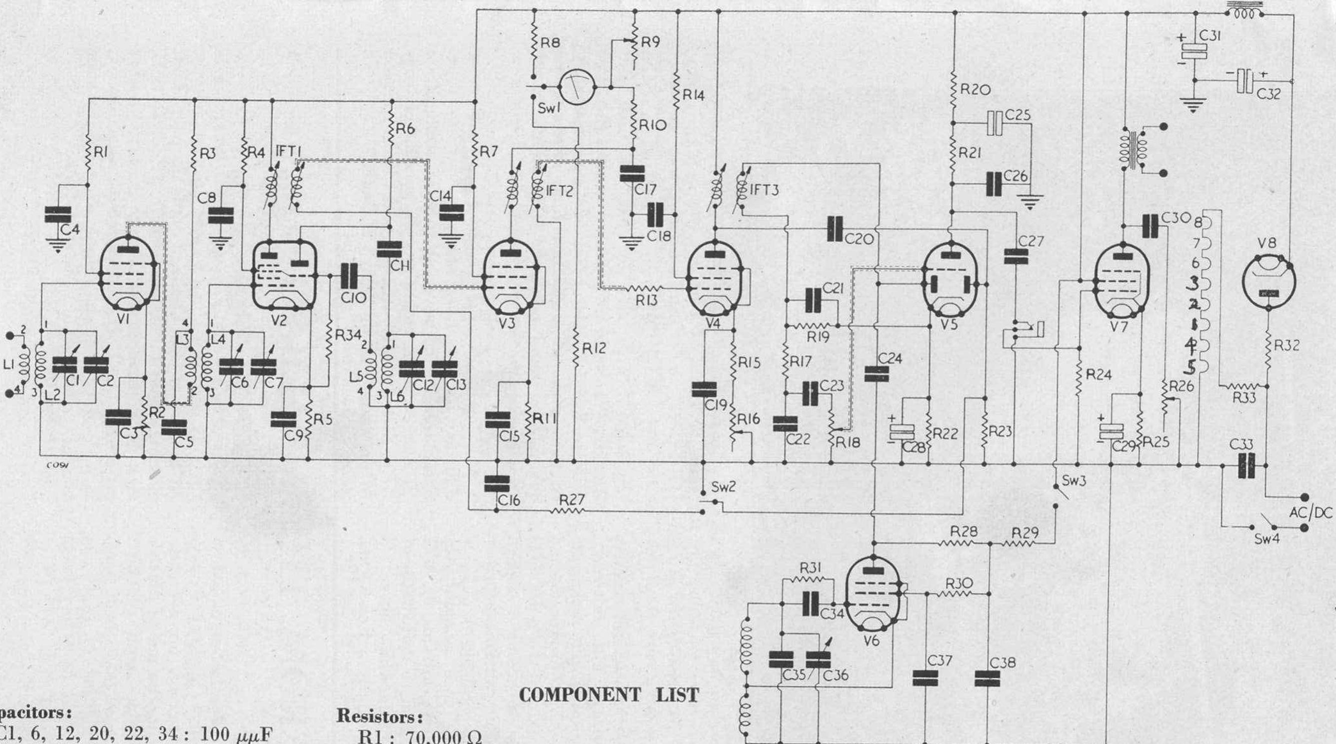
L1, 3, 5—25 turns close wound over earthy end of secondary.

L2, 4, 6—100 turns close wound

With the meter switch on and the AVC switch off the needle flew over against the pin. R9 was adjusted until the needle returned to zero then the AVC was switched on, further slight adjustment of R9 was necessary to return needle to zero. All adjustments were carried out with no signal being received. The IF gain control has an effect on the meter readings so this must be set at a pre-determined spot if a set scale is used on the meter or comparisons are to be made between different signals. The three pole meter on/off switch was incorporated to isolate the instrument if the receiver is tuned to a strong signal with the AVC in operation.

The receiver is built around an aluminium chassis, 18 swg, 15in. x 9in. x 3in. and the panel is of mild steel, 18 swg, 16in. x 9in. The diagrams give some idea of the lay-out and appearance, the " hoops " ($\frac{1}{2}$in. x $\frac{1}{8}$in.) give ease of handling, especially when the receiver is up-ended for any purpose, as it can stand on these without having to balance on the valve caps ! All screens and capacitor mounting brackets are made of substantial gauge aluminium and the latter were made as short as possible to minimise whip, etc. The flexible couplers also help to reduce this.

Perhaps it should be mentioned that no signal generator or other aligning apparatus was used



COMPONENT LIST

Capacitors:

C1, 6, 12, 20, 22, 34 : 100 $\mu\mu$F
C13, C2, 7 : 15 $\mu\mu$F
C3, 4, 8, 9, 14, 15, 16, 17, 18, 19, 27, 37, 38 : 0.01 μF
C10, 11 : 50 $\mu\mu$F
C21, 26 : 300 $\mu\mu$F
C24 : See text.
C25, 31, 32 : 8.0 μF
C28 : 50 μF 12V wkg.
C29 : 50 μF 50V wkg.
C30 : 0.05 μF
C33 : 0.01 μF, 1,000V wkg.
C35 : 500 $\mu\mu$F
C36 : 60 $\mu\mu$F
C5, 23 0·01 μF

Resistors:

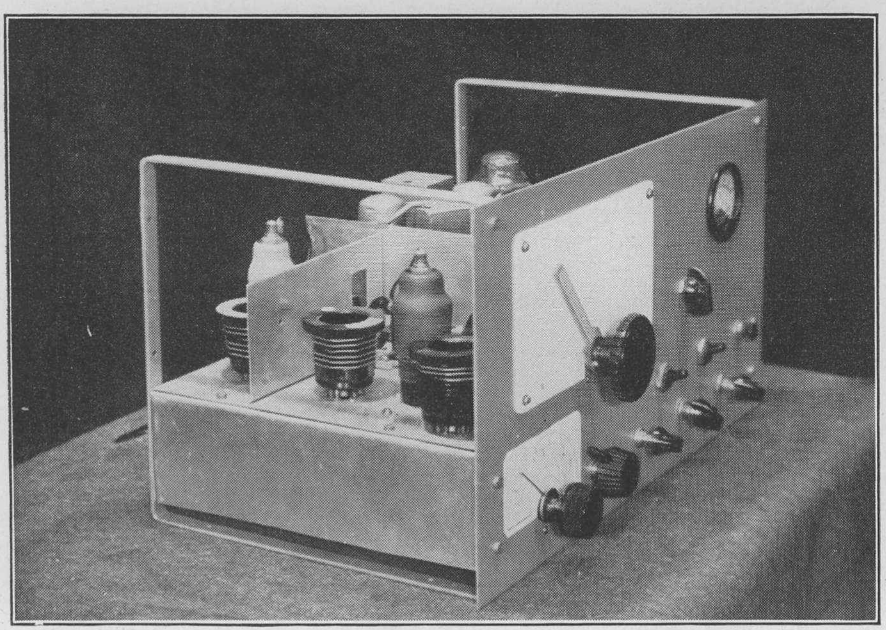
R1 : 70,000 Ω
R2, 15 : 330 Ω
R3, 8, 9 : 1,000 Ω
R4 : 33,000 Ω
R5 : 200 Ω
R6 : 45,000 Ω
R7, 12, 21, 30 : 100,000 Ω
R10, 22 : 2,000 Ω
R13 : See text.
R14 : 68,000 Ω
R16, 20 : 10,000 Ω
R17, 31, 34 : 50,000 Ω
R18, 27 : 500,000 Ω
R19, 24 : 250,000 Ω
R11 330 Ω
R23 : 1 M Ω
R25 : 700 Ω
R26 : 25,000 Ω
R28 : 20,000 Ω
R29 : 30,000 Ω
R32 : 47,~~000~~ Ω
R33 : Line-cord 0.2A, approx. 870 Ω

Valves:

V1 : EF39
V2 : CCH35
V3 : EF39
V4 : EF39
V5 : EBC33
V6 : EF39
V7 : EL32
V8 : CY31

Miscellaneous:

SW1 : Meter on/off
SW2 : AVC on/off
SW3 : BFO on/off
SW4 : Mains on/off (with R18)
LF Choke, 15H, 100 mA (or speaker field)
Meter : 0-1 mA



The controls on the receiver are as follows : the large dial is for bandspread, the small (lower) dial is main tuning. The controls along the bottom are RF gain, IF gain, AF gain and tone control. The three switches above these are, reading left to right—AVC (Sw2), BFO (Sw3), Meter (Sw1). Above the switches are the Pitch Control and "S" Meter.

unless QRM from neighbouring vacuum cleaners can be included in that class. The dust-cored IF transformers were trimmed for maximum gain by ear, utilising the hiss produced, and gradually reducing the IF gain as the noise level increased. In any case, it does not matter if they are a bit off tune as this can be taken care of by the separate tuning controls.

Results obtained taking into account the aerial in use have been very gratifying on both 10 and 20 meters. The signal to noise ratio on the lower frequencies is somewhat lower. A 10 meter doublet does not exactly match 80 and top band ! Five sets of coils are used and thanks to the separate oscillator control the three coils in use for each band are wound exactly the same although a few turns more or less on the 80 and top band oscillator coils do not make a lot of difference.

The handling of the set presents no particular difficulty or anything abnormal for its type. Some DX logged at good speaker strength on 10 metres when conditions favourable includes KG6, ZL4, J9, CR9, LU, CE, and VK, in addition to the usual run of W's, VE's, etc.

FROM THE MAILBAG

Dear OM's,

I note that F. T. A. Randall agrees with E. J. Clarke about the poor quality of valve bases and I also agree. Surely, however, the answer to this question is in the use of Button Base valves, either battery or mains types. I have used these valves and find them most satisfactory and since a number of types are now obtainable I suggest that more use could be made of them.

Best wishes,
M. F. SMITH, G1503 (Morecambe).

Dear Sirs,

The article describing my signal generator in the July issue contained a small error, as follows: At the end of Output Stage data, the part about cathode capacitor should read: " . . . If O/C, it can be checked by shunting with another capacitor . . . " If this were S/C, as published, it will, of course, show up during the cathode voltage and cathode resistance tests.

Sincerely yours,
L. F. SINFIELD (Luton).

BOOK REVIEW

"Radio Calls of the World," published by the New Zealand DX Radio Association. 44pp. Demy 4to. 2/6.

This publication will be particularly welcomed by those of the fraternity who are interested in Medium Wave DX. Split into suitable sections are lists of North and South American stations, those from the East, Europe and Africa. In these lists, given in order of frequency, the call sign, power and time zone are shown. In addition, a complete list of Australian and New Zealand broadcasters with schedules are included. A sizeable list of world-wide short wave stations, complete with schedules, is another useful feature of this publication.

Another section gives medium wave stations by call sign, alphabetically. For the amateur station fan, there is a full list of the addresses of all VK hams. A few odd items completes what is surely one of the best half-crown's worth that the medium wave DX-er is likely to encounter.

Though this excellent publication was published primarily for NZ DX.RA members, it is available to readers in this country at 2/6, post-paid. The address is The Secretary, NZ DX.RA Inc., 20, Marion Street, Wellington, C.2, New Zealand.

W.N.S.

TRADE REVIEW

We have received from the Woden Transformer Co., Ltd., copies of their latest catalogue leaflets describing their well-known mains transformers, chokes and modulation transformers. Types and sizes to meet all amateur requirements are available and those contemplating a rebuild needing components of this type are strongly recommended to send for these leaflets before making their purchases. Details are also available of a very useful range of standard replacement mains transformers most useful to the service engineer and a further interesting line is a series of Auto transformers rating from 60 to 1,000 watts. This literature and the latest retail price list can be had on application to the firm at their Moxley Road, Bilston, Staffs., address.

TRADE NOTES

Stratton & Co., Ltd., announce that the price of their popular Eddystone 640 Communications Receiver has been reduced to £27/10/0—free of purchase tax. In order to enable as many amateurs as possible to enjoy the possession of one of these receivers, Strattons are also prepared to offer very generous Hire Purchase facilities, details of which can be obtained from their Registered Agents.

The characteristics of this receiver are too well-known to amateurs to need further comments from us. May we remind readers that it is designed specifically for Amateur Band use, covering all bands from top-band to ten. It is a nine valve job, with RF stage, noise limiter, BFO and crystal filter and all the other usual refinements required by the discriminating amateur. At this new low price, we feel certain this receiver will become one of the most popular to be found in British Amateur shacks.

An interesting addition to the Eddystone range of receivers is the "670" Marine Receiver. This receiver is intended for "personal cabin use," for those who are at sea and are thus often out of range of medium-wave broadcast stations and who, therefore, require a reliable short-wave receiver. The frequency coverage is 30 Mcs.—522 kcs. in four bands and the receiver has many unique features, such as AC/DC operation on voltages varying from 110-230, interference filter unit, provision for headphones or "personal speaker," etc. The price is £37/10/0—free of purchase tax.

Clydesdale Supply Co. have sent along their "Supplement 4A." This 32 page catalogue is published in order to bring up-to-date the existing List 4. Little need be said except to mention that the usual large range of surplus equipment is shown. Copies may be obtained from Clydesdale at 2, Bridge Street, Glasgow, C.5.

Evert Kaleveld, PAoXE, Zeilweg 35rd, Haalem, Netherlands, would be very pleased to send data of any German valves to readers of the *Short Wave News* or the *Radio Constructor.* He requests that an International Reply Coupon be sent to cover postage, please.

An Introduction to the Theory of Thermionic Valves

By Kenneth R. Goodley

Part 6

(a) Alternating Potential Applied to Diode.

In Fig. 14a an alternating potential is applied to the Anode and Filament of a Diode.

The positive half-cycles will make the anode positive with respect to the filament, and for the period of their duration current will flow across the valve. During the negative half-cycles, however, the anode will be negative to the filament and no current will flow.

If the meter—M—reads Direct Current only, the positive and negative half-cycles would cancel out if the valve were to conduct in both directions. Since only the positive half-cycles cause an electron flow in the valve, the average value of the applied voltage will be the mean average of the positive peaks of current, and therefore also positive (Fig. 14b). If the alternating potential is produced by a circuit tuned to some broadcast frequency, the input will (normally) be varying rapidly in amplitude and the average value will be varying at an audio frequency and could therefore be heard if a pair of headphones replaced the meter (Fig. 14c).

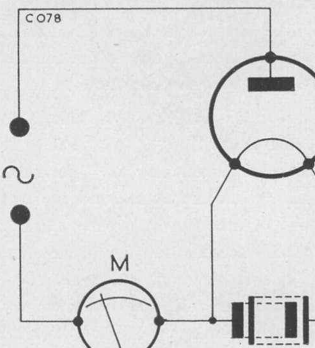


Fig. 14a.

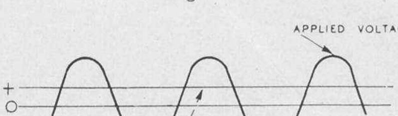


Fig. 14b. Showing current flow in 14a.

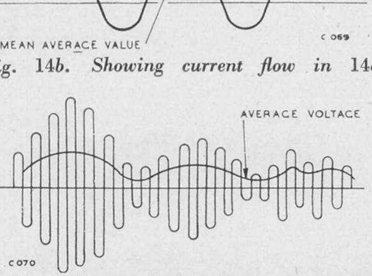


Fig. 14c. The negative half-cycles are removed. If the input varies in amplitude, the average value will, also.

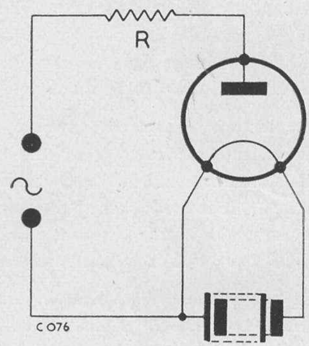


Fig. 15a.

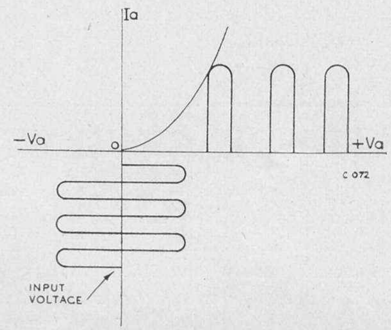


Fig. 15b. The output pulses of current are those flowing through "R" in Fig. 15a, which produce voltage pulses across it. Positive half cycles (input) produce pulses of current.

(b) Resistance in Anode Circuit.

If the circuit of Fig. 15a is connected up, the pulses of current across the valve flow through R and produce voltage pulses across it (Fig. 15b).

If, as will be discussed later, the pulses of current are "amplitude modulated" (e.g., varying in sympathy with the input from a tuned circuit) the voltage pulses will do likewise.

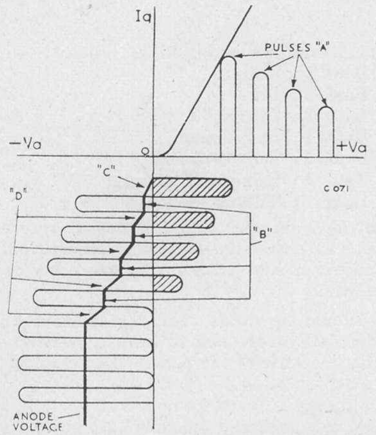


Fig. 16. Pulses "A" are decreasing pulses of current charging up capacitor. Codings are: "B"—Charge on capacitor is constant, since there is no electron flow during negative half-cycles. Therefore, the anode remains at constant negative voltage during each negative pulse. "C"—Anode becomes negative due to charge on capacitor. "D"—Further negative bias on anode due to flow of electrons to capacitor. N.B.: The "cut-off" input pulses show that positive half-cycle is equal to negative potential on anode. Maximum Va is 0 (zero) so that there is no further flow of electrons.

(c) Capacitor in Anode Circuit.

If the resistance R of Fig. 15a is replaced by a capacitor, the effect is rather different.

As before, electrons begin to flow during the positive half-cycles, but since current cannot pass through the capacitor, the latter is charged up, the anode voltage falling rapidly until the positive half-cycles equal the negative potential on the anode, making the maximum anode voltage zero, and stopping current flow entirely. This may be seen more easily from a study of Fig. 16.

(d) Capacitor and Resistor in Diode Anode Circuit.

Fig. 17b indicates the position when both capacitor and resistor (in parallel) are inserted in a Diode circuit (as in Fig. 17a). During the first positive half-cycles, electron flow commences and the capacitor charges up. The negative half-cycle partially discharges the capacitor by current flow through R. Meanwhile, the anode has become more negative, so that during the second positive half-cycle slightly less current flows to maintain the DC through R and charge up the capacitor. During the second negative

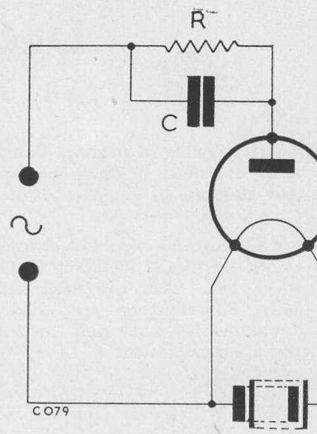


Fig. 17a.

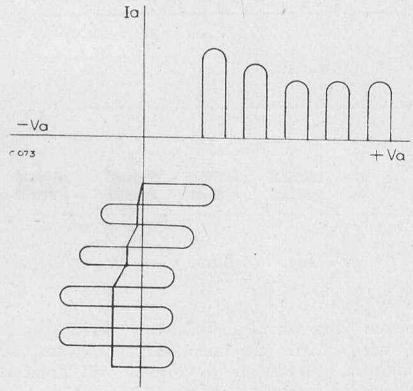


Fig. 17b.

half-cycle C again partially discharges, maintaining the current through R. This continues until ultimately a state is reached where a constant potential difference, varying somewhat at input frequency, is maintained across C and R.

(e) The Diode as a Detector.

The L-C circuit applies a constant amplitued, alternating PD to the diode. (See Fig. 18).

During pre-signal conditions, the anode voltage may be regarded as zero.

During the first positive half-cycles, electrons flow through the valve and around the circuit via resistance R.

Capacitor C becomes charged and the anode is biassed negatively, so that when the second positive half-cycle is applied, this bias has to be overcome before current flows through the valve.

During the negative half-cycles, C discharges through R, to an extent dependent upon the size of the resistor.

(*continued on page* 376)

Resistance and Capacitance Decade Box

By A. R. COPPIN

ALTHOUGH similar workshop equipment has been described in these pages, it is felt that this unit is compact whilst very versatile.

It is unique inasmuch as *any* value of resistance may be obtained up to and including 11,111,110 Ω in steps of 1 Ω. This has been achieved although only 28 resistors are used. The capacitance obtainable, while not so wide in range, is very accommodating.

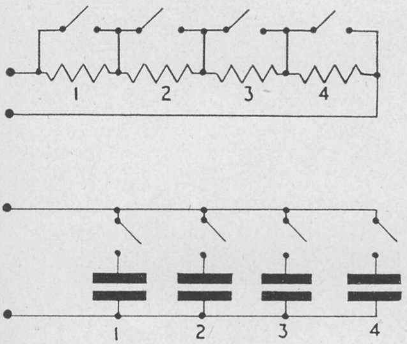


Fig. 1. Basic Circuits.

Circuit.

Seven five-way push-button switch units are used with the necessary resistors and capacitors. Reference to Fig. 1 will illustrate the general principle used.

Each button (switch) is used for the dual purpose of capacitance and resistance.

Supposing the values in Fig. 1 to be unity, i.e., 1, 2, 3 and 4 Ω, it can be seen that by closing switch 2 and 3, resistors 2 and 3 are short circuited, leaving a total of 5 Ω. Similarly, if switch 1 is closed a total of 9 Ω is left. All switches open equals 10 Ω, all switches closed equals zero Ω. Thus, by using seven banks, any value may be obtained.

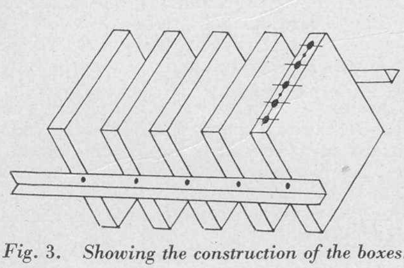


Fig. 3. Showing the construction of the boxes.

The banks are arranged as follows :—

Bank 1 : Units.
Bank 2 : Tens.
Bank 3 : Hundreds.
Bank 4 : Thousands.
Bank 5 : Ten Thousands.
Bank 6 : Hundred Thousands.
Bank 7 : Millions (Meg Ω).

Button 5 on each bank is used to return the buttons to zero. By depressing all fifth buttons the unit is at zero Ω, ready to select any desired resistance.

It should be noted that depressing a button removes the short circuit from a resistor, thus making marking of the panel direct reading, e.g.,

Buttons 2 and 4 equals 6 Ω.
,, 2, 3 and 4 equals 9 Ω.
,, 1, 2 and 4 equals 7 Ω.

Capacity is obtained in much the same way except that when two buttons are pressed, two capacitors are switched in parallel, thus adding their individual values. If buttons 15 and 18 are depressed a total of 5,500 Micro-Micro-farads are obtained (.0055 μF).

A double pole double throw switch is used to change from resistance to capacitance. This can be dispensed with if two pairs of terminals are used.

In Fig. 2 only two units are shown in detail, the other five are shown in block diagram form.

Components.

The push-button switches are ex-government surplus and are obtainable from several advertisers in this journal.

Resistors of the one watt type may be used for values of 1 K Ω and over. Below this value the constructor can wind them with any suitable resistance wire. Actually only three are needed, 10 Ω, 100 Ω and 1,000 Ω, these are tapped in the ratios 1 : 2 : 3 : 4.

All these resistors are only in the circuit being tested a short while so no overheating should result.

Capacitors of 2 μF and over should be of the electrolytic type for compactness, although the paper types can be used at the expense of space. The smaller capacitors may be the tubular types. If the constructor intends to use this unit on high voltage apparatus, such as transmitters and certain parts of television receivers, the capacitors must be of corresponding working voltages. If using electrolytic capacitors, strict polarity must be observed.

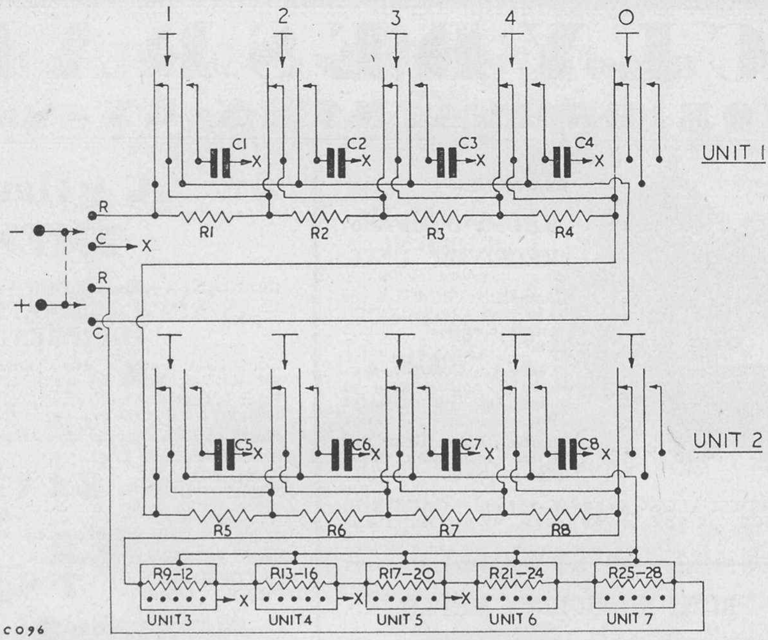


Fig. 2. Theoretical circuit of complete unit.
All points marked " X " are connected together.

LIST OF COMPONENTS.

Capacitors.

C1	50 μF	50v.	C11	.1 μF
C2	25 μF	50v.	C12	.05 μF
C3	32 μF	450v.	C13	.02 μF
C4	16 μF	450v.	C14	.01 μF
C5	8 μF	450v.	C15	.005 μF
C6	4 μF	450v.	C16	.002 μF
C7	2 μF	450v.	C17	.001 μF
C8	1 μF		C18	500 μμF
C9	.5 μF		C19	200 μμF
C10	.25 μF		C20	100 μμF

Resistors.

R1	1 Ω	See Text (R1–R12)	R15	3 K Ω
R2	2 Ω		R16	4 K Ω
R3	3 Ω		R17	10 K Ω
R4	4 Ω		R18	20 K Ω
R5	10 Ω		R19	30 K Ω
R6	20 Ω		R20	40 K Ω
R7	30 Ω		R21	100 K Ω
R8	40 Ω		R22	200 K Ω
R9	100 Ω		R23	300 K Ω
R10	200 Ω		R24	400 K Ω
R11	300 Ω		R25	1 Meg Ω
R12	400 Ω		R26	2 Meg Ω
R13	1 K Ω		R27	3 Meg Ω
R14	2 K Ω		R28	4 Meg Ω

Construction.

If a sound job is to be made of this " instrument " the switches must be mounted rigidly.

A stout box or case should be obtained, this may be either wood or metal. The author had a metal box on hand so use was made of it. The box was somewhat wider than was necessary, and the extra space at the side was therefore used to accommodate the capacitors. The box used measures 6½in. x 10in. x 3½in.

The push-button units were drilled and tapped 1¼in. from the top of the frame exactly in the middle of the sides.

Two pieces of angle metal are required next. The author used metal supplied with a " Juneero " outfit. Any metal may be used, or even wood, but it must be strong and rigid. These should be cut to the exact length of the box; this is to prevent movement of the bars lengthwise. Seven holes 1in. apart are drilled along the length of these bars. The bars are then bolted to the side members of the switches. Before doing this, however, there is one important point: these switches incorporate a locking device which prevents more than one button

(*continued on page* 372)

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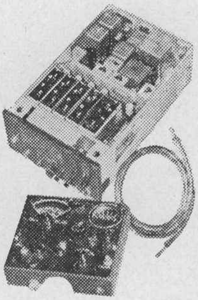

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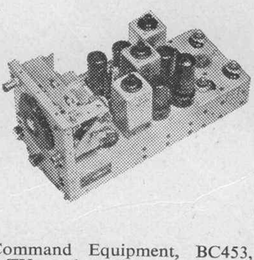

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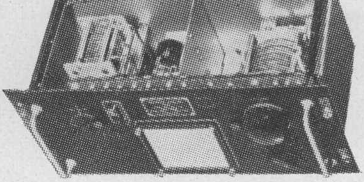

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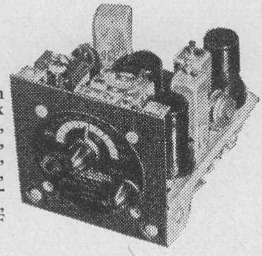

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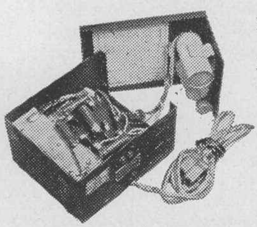

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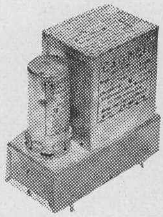

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Query Corner

A " Radio Constructor " service for readers

Faulty Output Stage.

" *I have a communication type receiver in which the output transformer is connected to the speaker via a jack plug and socket. The receiver gave satisfactory results until recently when it was switched on for a short period of time before the speaker was connected. Upon connecting the speaker I was surprised to obtain no results, Is it possible to damage the receiver by operating it without a speaker ?* "

—*G. Longley, Birmingham.*

The answer to this query is that it is possible to damage the output stage of a receiver by operating it without a load, or in other words, without a speaker connection. The impedance of the primary of an output transformer is very high compared with the impedance of the combined speaker and transformer. This is because the impedance of the loudspeaker, usually about 3 Ω, is reflected into the primary of the transformer ; the value of the reflected impedance being determined by multiplying the square of the turns ratio of the transformer by the speaker impedance. Now consider the effect of operating the output valve with just the transformer as a load. The DC resistance of the load is low so that when no signal is present the valve is operated under normal conditions. However, when a signal is fed to the valve the sudden changes in anode current result in the production of a voltage across the transformer which, at times, may have a high peak value. It is well-known that such a voltage is produced across an inductance when the current flowing in the inductance is caused to change suddenly. It is this voltage which, if allowed to exist across the output transformer may result in the breakdown of the insulation of either the transformer itself, the tone correcting capacitor, which is invariably connected across its primary, or the valve. Such an insulation breakdown will present a heavy load to the power supply and no attempt should be made to operate the receiver until the trouble has been remedied. A simple insulation test will soon indicate the faulty component, which, incidentally, is most likely to be the tone correcting capacitor.

If, in any circumstances, it is possible for a receiver to be unintentionally operated without the connection of a speaker, it is advisable to connect a dummy load of about 5 Ω across the secondary of the output transformer ; this load being cut out of circuit when the speaker jack is inserted in its socket. This may be readily achieved by the use of a double circuit jack socket.

AC/DC Receiver.

" *I intend to construct the AC/DC receiver described in your April,* 1948, *number, but I would like some further details before commencing work. For example:—*

(1) *A line cord is a nuisance and I would prefer to use a* 0.1 *amp. dropping resistor or barretter, if either of these components is obtainable.*

(2) *Is there a more powerful output valve in the* 0.1 *amp. loctal range than the UBL-*21 ? *If so, I would like to use it.*

(3) *I presume that a speaker energising field may be used in place of the resistor R-*8. *Would this in fact be preferable ?*

(4) *Would sufficient screening be obtained by placing one coil above the chassis and one below it with their axes at right angles ?*

(5) *Can an efficient tone control be used in conjunction with* C13 ? "—*J. Wortman, E.Sheen.*

This enquiry is included as considerable interest has been shown in this particular universal receiver which, as it only employs two valves and a metal rectifier is capable of being packed into a miniature cabinet. The performance of the receiver is at least equal to that of any 1-V-1 receiver. The use of the triode-hexode valve type UCH-21, because the two sections have no connection apart from a common cathode, enables the hexode section to be used as an RF amplifier and the triode section as the detector. One or two readers have written to tell us that they have constructed the receiver using a press button unit as a station selector thus rendering the dial and two-gang capacitor unnecessary, and making a further reduction in size possible. This method of tuning may be readily achieved by substituting the gang capacitor by a series of preset components, each pair selected by means of the press button unit.

Now to return to the points raised by our correspondent and taking them in order, the answers are as follows :—

(1) Whilst we agree that a line cord is not an ideal solution to the problem of controlling the heater current it is nevertheless the most satisfactory method for this receiver. A line cord of the type intended for use with the 150 mA series of American valves will prove to be quite satisfactory and is readily available. However, a power resistor capable of dissipating about twenty watts may be used if desired and should be mounted in such a position in the cabinet that the heat generated may be readily dissipated. Possibly the best position for such a component is at the top back of the cabinet, ventilation

holes must be provided to allow a free circulation of air throughout the cabinet. No mention has been made of the possibility of using a barretter, as it is understood that one capable of controlling 100 mA is not readily obtainable in this country.

(2) As far as is known there is no valve in the 100 mA loctal range capable of producing a greater output than is obtainable from the UBL-21. This valve is capable of providing an output power of about 4½ watts at 200 volts, an output which is more than ample for a receiver of this type, and thus, with the use of resistance smoothing for the HT the voltage is reduced to a value such that an output of 1.5 watts may be obtained. However, if a greater output is required the smoothing resistor R-8 should be substituted by an LF choke and R-9 should be increased to 200 Ω. It must be remembered that if a 4 watt output is to be obtained an 8in. speaker should be employed.

(3) The resistor R-8 may be replaced by means of a speaker energising winding, the use of such a speaker saves the space which would otherwise be required for R-8 or the smoothing choke, and provides ample smoothing for the HT. In this case, the resistor R-9 should have a value of 200 Ω.

(4) It is sufficient to place the tuning coils one on either side of the chassis, the one on the lower side being mounted horizontally whilst the upper one is vertical. Connecting leads to the coils should be as short as possible in order to reduce the inter-wiring capacity to a minimum ; this will preserve the stability of the receiver.

(5) A tone control is an added advantage in any receiver and may be conveniently incorporated in this set by substituting C13 by means of 0.02 μF capacitor connected in series with a 20 k Ω potentiometer. This system will provide a range of tone control which is sufficient to suit all requirements. See also note at foot of next column.

Poor Focus.

" *The oscilloscope which I am constructing has now reached the testing stage, but I find that with no voltage applied to the deflector plates the spot, although central on the screen, will not focus sharply. What is the most likely cause of the trouble ?"—P. Smith, Hall Green.*

This is quite a common fault in the home constructed oscilloscope and may generally be traced to one of three causes ; interference picked up on deflector plate heads, tube placed within the magnetic field of a transformer or choke, or a faulty tube. The first point may easily be checked by connecting all four plates directly to the final anode of the tube. If the focus improves steps should be taken to screen the leads, and the resistors connected between each plate and the final anode should be tested. Should one of these resistors be open circuited, one of the plates will collect a negative charge and will give a deflection of the spot and may, at the same time, cause a poor focus.

Interfering magnetic fields often prove to be very troublesome but an improvement will generally be obtained by moving the source of the field with respect to the tube. This usually means moving, or merely turning the mains transformer. Such attempts may not prove to be entirely satisfactory in which case a mu-metal screen must be placed around the tube neck.

These screens are readily obtainable at the present time and the ex-WD types will be found to be reasonably priced.

Before suspecting the tube of being faulty it is worth while to check the EHT smoothing capacitor, which if not functioning in its right capacity may cause very bad focus. However, if the tube is faulty it is most likely that the vacuum is poor in which case the getter deposit on the glass wall near the base of the tube will have a furry appearance. This deposit should have a blackish appearance with a trace of silver. Should there be any sign of it turning white around the edge, the tube may be assumed to be useless.

"Query Corner" Rules

(1) A nominal fee of 1/- will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57, Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with the more general interest will be reproduced in these pages each month.

AC/DC RECEIVER

Arising from the original query with the above title (see April 1948 issue, page 241), one or two obvious discrepancies in the component values have been queried. The anode feed-back resistor, R6, should be 100 Ω or a similar low value, and not 100,000 Ω as shown. The anode by-pass capacitor, C13, was printed as 500 μF—obviously a wrong value! In this case the figures had been reversed in printing, the correct value being 0.005 μF. It may be noticed that reaction is affected by the manipulation of the audio gain control (R7). This is due to RF getting through to the AF stage and the cure lies in the insertion of a 500 $\mu\mu$F (or thereabouts) capacitor between the junction of R5/R6 and the negative line.

Improving Low Note Response

By C. H. Webb

THE quality of most receivers is judged by their reproduction of the lower frequencies. In general this is poor and may be due to a variety of faults. Loudspeakers are relatively inefficient below 100 cycles, whilst gramophone recordings fall off at 250. The frequency range of a considerable number of musical instruments falls below these figures and it may seem to the discerning amateur that the only remedy lies in an expensive quality receiver.

However, at very little expense the bass response of the average receiver can be improved upon. Examination of the AF section of one amateur-constructed set showed that it was impossible to pass frequencies below 400 cs. This was due to a bad choice of coupling values.

In the R-C coupled stage of Fig. 1 the relative values of C1 and R1 determine the lowest frequency that will pass without being attenuated to 70.7 per cent of its original voltage. That is because these two components form a potential divider between the anode of V1 and earth. Voltage developed across the capacitor is lost, and as its reactance increases with a decrease in frequency a point is met among the bass notes when "cut-off" occurs. At this point the reactances of the two components are equal.

A sensible value at which to fix this "cut-off" is around 60 cycles. Below this figure a variety of troubles can be run into. There is a risk of over-loading, and if carried down too much mains hum and "motor-boating" can arise.

Suitable coupling values are shown in Fig. 2, "cut-off" occurring around the figure quoted. If no trouble is experienced and it is found that the loudspeaker is able to handle even lower frequencies this figure may be halved by doubling either C1 or R1.

Transformer Coupling.

In the straight-forward transformer-coupled stage we have a similar problem (Fig. 1b). In this case though there is the inductive reactance of the primary and the AC resistance of V1 to be considered. To pass the lowest frequencies it is necessary that the reactance shall be as high as possible compared with the anode resistance of V1.

Having decided on our frequency we can now determine the primary inductance of the transformer and also the valve required. "Cut-off" will occur when $f = \frac{ra}{2\pi Lp}$

Alternatively, this may be expressed:— $ra = 2\pi f Lp$ or $Lp = \frac{ra}{2\pi f}$

Checking the AF section with these formulae it is often possible to make improvements. In some cases the frequency has been set too low and a valve with a higher AC resistance and consequent greater amplification can be substituted.

For example where 60 cs. is the lowest required and the primary inductance is 90H a valve with an impedance of 33,900 Ω is needed. Below this figure there will be a loss of gain and above it a reduction in low note response.

At this point the "bogey" of transformer-coupling crops up. The primary inductance has been quoted as fixed, whereas in practice it is likely to vary a good deal. This is due to the changing anode current of the valve. With a large current the core becomes saturated and the inductance can fall to a very low figure.

This can be overcome by the familiar system of parallel-feed (Fig. 1c). As far as low notes are concerned this can lead to some very interesting results.

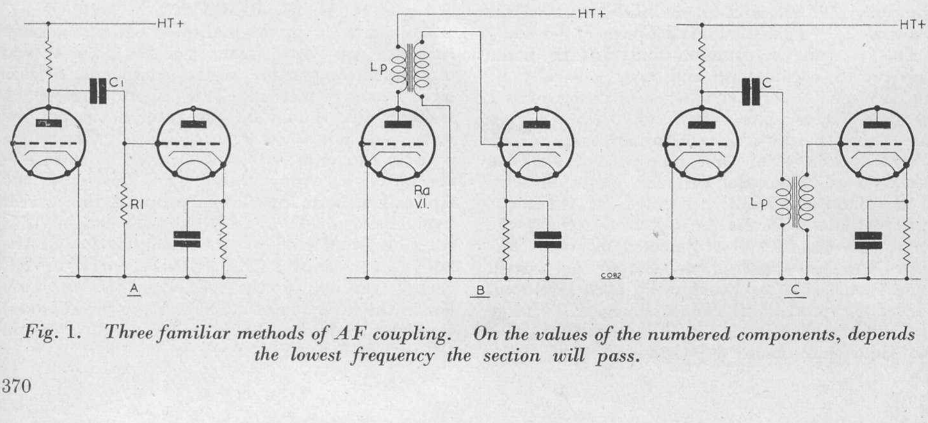


Fig. 1. Three familiar methods of AF coupling. On the values of the numbered components, depends the lowest frequency the section will pass.

It will be seen that C1 is in series with the transformer primary, thus forming a tuned circuit. By a suitable choice of values this can be made to resonate to the lower frequencies. Fig. 3 shows that in effect this acts as a boost.

As can be seen it is a fairly flatly-tuned circuit by reason of R and ra, which are in parallel with it. A few experiments with the value of the coupling capacitor will bring the low note response down to an extreme figure.

C1	R1
0.025 μF	100,000 Ω
0.01 μF	250,000 Ω
0.005 μF	500,000 Ω

Fig. 2.

Tone Correctors.

The conventional method of maintaining good bass response is by the introduction of a tone corrector circuit. Strictly speaking this has only the effect of cutting down the high notes and it is at their expense that the lower notes are amplified. In cases where pentode valves are used for output a tone corrector is very much desirable, however.

Fig. 4 shows a typical circuit. C and R act as a shunt across the output transformer. By virtue of the capacitative reactance, though, the resistance of this shunt will be larger at the lower frequencies. Therefore a proportion of the power of high notes will be shunted away from the loudspeaker.

Alternatively, the shunt may be connected between anode and earth. If the resistance is made variable in either case the amount of correction can be suited to the listener's taste. Another simple remedy is to damp the secondary of the AF transformer by connecting across it a resistance of value between .1 and .5 Meg Ω.

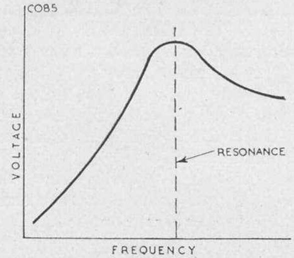


Fig. 3. *The coupling capacitor and transformer primary in a parallel-fed circuit act as a tuned circuit, resonating to a particular group of frequencies. The curve shown above demonstrates how this acts as a boost to bass notes.*

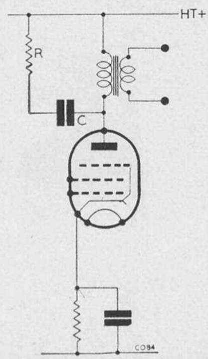


Fig. 4. *Typical tone-corrector circuit for output pentodes. R and C act as a shunt, whose resistance is less to high notes than it is to bass. Alternatively, R and C may be connected between anode and earth. Usual values are* 0.01 μF *and* 10,000 Ω.

Negative Feedback.

Of increasing popularity are those circuits utilising the theory of "negative feedback." This is used normally to check the amount of harmonic distortion in pentode valves. With a slight reduction in gain we also get an improved bass response and absence of background "hiss."

Briefly, the theory is that a proportion of the amplified voltage reaching the anode shall be fed back to the grid in opposite phase to the input voltage. There are a very great variety of circuits which may be used. The two most usually met with are shown in Fig. 5. The simplest is shown in (a) and involves nothing more than the disconnection of the cathode capacitor. This proves remarkably effective. In some cases, however, it may lead to speaker resonance. This is due to an increase in valve impedance and consequent reduction in the damping on the loudspeaker. All the same it is a trick worth trying and will not unduly effect a good instrument.

Fig. 6(a) is a safer and perhaps more conventional feedback circuit. The proportion of voltage fed back will depend upon the ratio of R1 to R2. To avoid much loss of output power their total resistance should be at least ten times the load resistance. Feedback required is usually about one-seventh, so that for a valve whose required load is 8,000 Ω suitable values for R1 and R2 would be 75,000 and 12,000 Ω respectively.

The Loudspeaker.

The last place for improving low note response is at the loudspeaker itself. A perusal of some manufacturer's data however does not seem very inspiring. Quite a few speakers seem to be unable to reproduce below 100 cs. Mainly it is a question of size. Treble notes are produced at the centre of the cone, whilst bass notes may be said to require the whole cone. Thus, the larger the speaker radius the greater the frequency range.

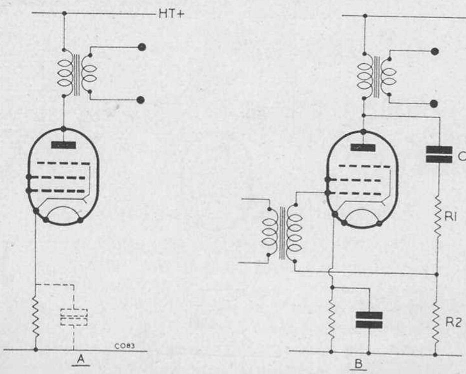


Fig. 5. Two circuits for negative feed-back. "A" is extremely simple and consists of the removal of the normal cathode capacitor. "B" is the conventional circuit. R1 may be 75,000 Ω and R2 is 12,000 Ω. A suitable value for C1 is 1.0 μF.

Alternatively, if the rim of the cone can be made more flexible the greater is its capacity to handle these lower notes. The more adventurous may care to paint this with a mixture consisting of equal parts of glycerine and water. This should be applied with a fine brush using very great care in confining it to the edge of the cone.

The most usual method of increasing speaker bass response is the addition of a baffleboard. The lowest frequency that will be produced depends upon the exact area of the baffle. For a nine square-foot type we can get as low as 30 cycles. Carried to an extreme measure the ideal method is to cut a hole in the dividing wall of a house. The hole should be in the centre and the speaker screwed securely round it. The wall will act as a baffle with an area of anything up to 120 square-feet with a consequent great improvement in low note response.

(*DECADE BOX—continued from page* 367)

being depressed at a time. This must be removed and is achieved by unscrewing two bolts at the ends of the underside of the units. These bolts may be used to bolt the angle pieces to the switches.

Inside the box are fitted two brackets at the ends, these are placed so that when the assembled switches are lowered into the box the angle pieces rest on them, thus taking the weight when any of the buttons are pressed. It is advisable to provide lips at the ends of these brackets to prevent side movement.

Next comes the panel. This, in the original model, was made of aluminium. This again is a matter of choice, any metal may be used, or wood.

The panel is drilled first with 35 holes to clear the buttons, a $\frac{7}{16}$in. drill is used, the spacing of the holes being $\frac{3}{4}$in. between buttons and 1in. between units.

Holes are drilled next for the D.P.D.T. switch and the terminals. These, of course, will vary with the items being used. Holes are drilled round the edge for screwing down panel.

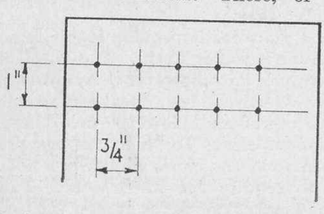


Fig. 4. Dimensions for drilling the holes.

Two holes already drilled will be seen in the top of each push-button unit. Holes corresponding to these are drilled in the panel and bolts with $\frac{1}{2}$in. spacers are used to bolt the units to the panel. This will give the necessary clearance to the buttons when in or out.

In the author's model most components were mounted directly on the switches, thus enabling the unit to be pulled out of the case without too many trailing wires. The larger components were fixed to the case with clips.

Nothing need be said about the operation. With use the operator can select any resistance speedily.

VOLUME ONE

Just a reminder that you can have your copies of Volume I bound. Those wishing to take advantage of this facility are asked to send their complete twelve issues, together with index sheet, to: J. R. Dunne, 19, Helmesdale Road, Streatham, London, S.W.16.

The books should be well packed to avoid damage in the post. Please state whether you wish to have the covers removed. The price, 8/-, includes return postage.

Arising from this, would readers please note that we are unable to supply back numbers of Volume I, with the exception of a very few copies of Nos. 4 and 5. PLEASE DO NOT ASK FOR OTHER BACK NUMBERS! We just cannot supply them. Sorry.

Inexpensive Television

By G2ATV & G3AYA

(Some weeks ago the office became gradually the centre of intense verbal duets between 2ATV and 3AYA. They spoke in an excited manner of such things as " erratic synch," " frame jump," " line slip " and " time bases." In other words, these two worthies had caught the Television Bug and judging from the inspired and exalted nature of their discussions the insect certainly had bitten deeply. Things got to such a stage that the only way we could induce any work out of them was to set them the task of compiling a series of articles on their experiments! Hence, we are able to present this month the first article dealing with the construction of a reasonably cheap yet efficient televisor.—Ed.).

Introduction.

ARE surplus cathode ray tubes any good for television? Does a 6 in. tube give a large enough picture? Is a green screen suitable? Is an electrostatic tube good enough, when commercial set manufacturers appear to have abandoned them in favour of magnetic deflection? How about cost?

Yes, these and many other questions arose in our own minds, too, at the outset, and we were in consequence rather dubious about the degree of success which we could expect. Now, we are both enthusiastic viewers, and have derived a good deal of fun in the process. As for the questions given above, we would not presume to make any dogmatic statements, but we will set down here the conclusions which we have drawn from our own experiences.

First, then, certain surplus tubes now being advertised are definitely capable of giving good pictures, and we can recommend the 5CP1 and VCR97 tubes which we ourselves used. Of these two, the VCR97 gives a slightly larger picture, needs a considerably lower voltage supply, and is not so sensitive to outside disturbances such as hum pick-up from nearby mains transformers. On the other hand, the definition obtained with the 5CP1 is slightly better, as the spot size is somewhat smaller due to the higher voltage on the final anode (intensifier).

Before we go any further, it may be as well to state here that we shall confine these articles to the gear and circuits which we ourselves have used, and that we do not propose to " stick our necks out " by discussing alternatives which may, or may not, work. To proceed, we find that the picture sizes obtained with these tubes, roughly 5ins. x 4 ins. or 6½ ins. x 5 ins., with some overlap, are sufficiently large enough to enable up to four persons to " look in " with some degree of comfort. On occasions, we have accommodated up to twice this number by a bit of judicious squeezing.

Now for the screen colour. The majority of commercial models use tubes with white screens, and a few use blue. To avoid confusion we would point out that all screens look white when not in use. When we talk of a blue screen here, we mean one where, when in use, the picture colour is light blue. Now the VCR97 and 5CP1 have green screens. In our opinion this colour is little, if at all, inferior, and in fact after the first few minutes the viewer ceases to notice the colour and takes notice only of the difference in shades. The contrast obtainable with these tubes is excellent, and there is no feeling of eye-strain even after a complete evening's viewing. The picture brightness is good enough to allow viewing in ordinary daylight, so long as light is not allowed to fall directly upon the face of the tube—though, of course, detail will be much improved if the room is darkened.

Despite the commercial trend, we have found these electrostatic tubes to be very suitable for our purpose—that is, to give a picture which though maybe not so sharp or so brilliant as that obtained with a magnetic tube, is nevertheless of good enough quality to provide a picture of real entertainment value. Also, of course, we are saved the trouble of finding or making suitable deflector coils. From the angle of cost, too, electrostatic tubes are available in large quantities in the surplus market at low prices. As for the cost of the complete equipment, this will naturally vary according to the amount of gear which the reader has on hand, but by making use of surplus material the outlay should not exceed £20 even if every component has to be purchased.

Main Equipment.

Before going into greater detail in each section, first let us give a summary of the main items used. The tubes have already been mentioned, and can be bought either as separate units, or complete with their respective indicator units.

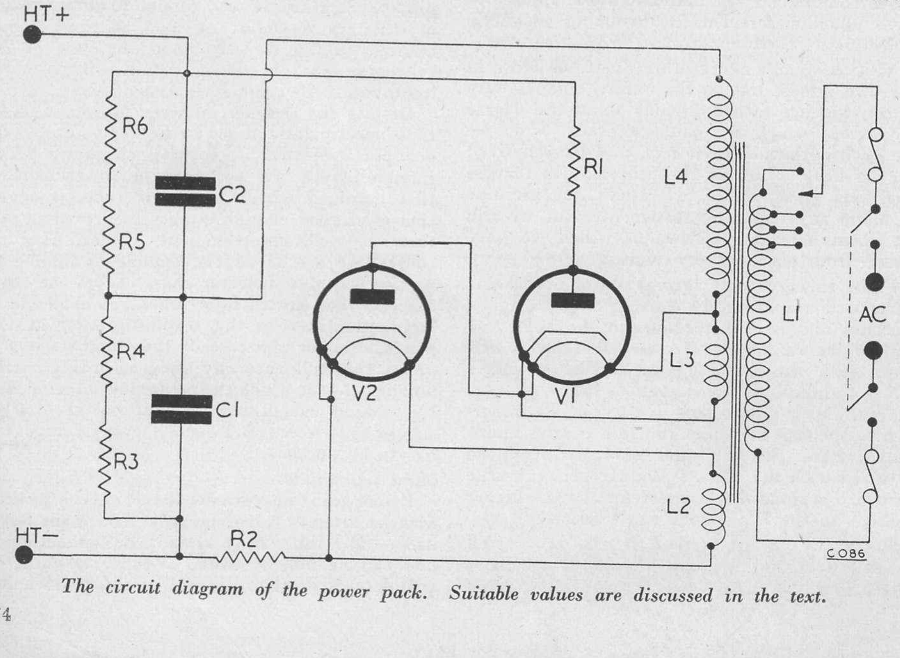
This latter method provides a convenient chassis for mounting the tube, and a supply of useful components to boot. For the E.H.T. supply we both used voltage doubler circuits, having the necessary rectifiers and mains transformers, which are not difficult to obtain. The synch and time base circuits were built " from scratch " to suit valves and components on hand. The valves used in this section are a 6J5 phase splitter, 6AC7 synch separator, 6AC7 frame and line oscillators, and 6SN7s for vertical and horizontal amplifiers—not forgetting an EA50 (VR92) diode for DC restoration. The power supply for this unit follows normal practice and uses a 350-0-350 transformer.

For the vision receiver we used what is probably the most sensitive receiver on the market at the present time—certainly more sensitive than the circuit used in many commercial televisors. This is the R1355 receiver (equivalent R1426) which contains 5 SP61 IF stages, EA50 diode detector, SP61 video amplifier and SP61 cathode follower output stage. This receiver is made to take the popular RF24-25-26-27 units, has a bandwidth of approx. 4 Mcs., and needs very little alteration for our purpose beyond the provision of a power pack, for which there is room on the chassis. For vision the RF25 unit is used, set to position 2 on the selector switch. The power supply can embody either a 250-0-250 or 350-0-350 transformer.

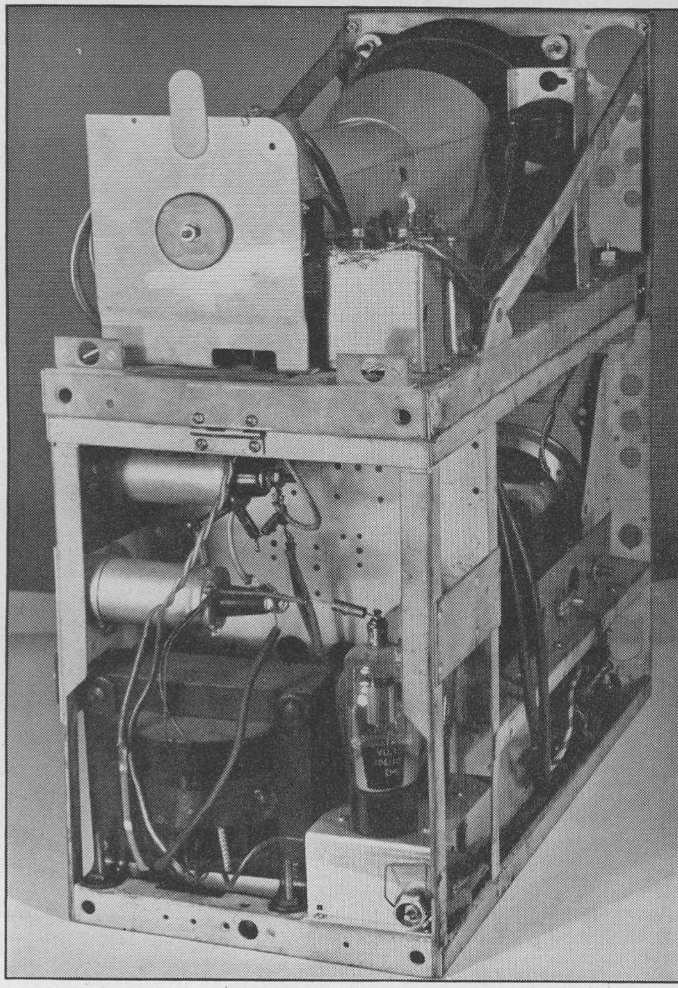
For television sound reception, 2ATV has tried two receivers, a simple superhet which was knocked up from the junk box, and an R1426 plus RF25 which was modified, both of which will be described later in this series. The former proved quite satisfactory for medium distance work, though there was some frequency drift which necessitated a panel trimmer to hold sound over a period of a few hours. The modified R1426 is, of course, much more sensitive, and the frequency drift is masked by the wide bandwidth which is employed, so that the only control needed is RF gain. 3AYA is using an RF25 unit coupled as a convertor to his BC348 receiver. With this arrangement, the receiver should be tuned to approximately 8 Mcs.—the IF of these units seems to vary somewhat from one model to another—and the unit switch should be set to position 1, with the appropriate trimmers set towards maximum capacity. Several other sound receivers have appeared in these pages from time to time, and maybe one of these would appeal more to the constructor as better suiting his needs—there is, after all, no point in building or converting a large receiver if the televisor is to be used within easy range of the transmitter.

EHT Power Supplies.

There are several methods of obtaining the necessary high voltage supply for the tube and its network, and the voltage doubler circuit chosen was employed simply because the components for it were easily obtainable. This circuit is shown in Fig. 1. V1 and V2 can be any suitable EHT rectifier to suit the voltage output of the windings L2, L3 and L4. The resistors R1 and R2 are intended partly for smoothing, and partly to limit the current flowing through the rectifiers in the event of a breakdown in the EHT circuit causing an overload. A suitable value is 100 k Ω, but it should



The circuit diagram of the power pack. Suitable values are discussed in the text.



This photo shows the rear o 2ATV's tube and time base chassis, and illustrates the set-up of the EHT power supply described in this article. It will be noticed that the tube is mounted in its original 6A chassis and that this is in turn placed on top of a WD surplus oscilloscope chassis which is used for the time base unit. A point to note is that the 6A chassis is hinged at the back, and removal of two screws at the front enables the chassis to be raised to permit easy access to the tube network, which is arranged on a mounting strip fixed to the underside of the 6A chassis. The pye socket in the bottom right corner takes the coaxial feeder from the vision receiver. The two potentiometers to the right of the tube are the X and Y shifts. To the right of these can be seen another pye socket, which is connected to the speech coil of the 5in. speaker, which is mounted in the aperture in the oscilloscope chassis normally used for the tube. This layout is not necessary, o course, but both chassis were on hand and advantage was taken of the fact that they were both of the same width and depth. The coupling capacitors between the deflector plates and time base amplifiers need to be placed as near as possible to the plates themselves. Two can be seen to the right of the tube base, the other two being hidden by the tube mounting bracket.

be noted that this value can be increased to form a convenient means of cutting down the voltage where the EHT winding happens to give an output greater than is required for the tube. C1 and C2 are of equal value, and should be 0.1 μF or larger, with an adequate working voltage rating. The bleeder network R3-4-5-6 may or may not be considered necessary, as the tube network itself constitutes a bleeder, but if used should consist of a series of separate resistors, as shown, in order to keep the voltage drop across each resistor to a comparatively low figure—not more than 500 volts across any one resistor—and thus remove any risk of " flash-over."

The EHT winding L4 may consist of a single winding, or two in series. As an example, 2ATV is using a transformer which was originally intended for an oscilloscope, and which has two high voltage secondaries, 350-0-350 and 800. In series this gives 1,500 volts, which doubles to 3,000 volts RMS, or 4,200 volts peak. R1 and R2 are 250 k Ω each, and R3-4-5-6 made to total 2 Meg Ω, so that with the tube and its network in circuit the EHT voltage to the tube is approximately 3,000V. It is possible to use less than this voltage, of course, and the VCR97 will work with 1,500 volts applied to it, but there will be less brilliance, and—what is perhaps more important—the spot size will be larger so that a clear picture is much more difficult to obtain. One point about the transformer—it is important that it should be a really first-class job, with the windings well insulated both from each other and from the core to withstand the high voltages present. Whilst on this matter of insulation, C1 may be one of those capacitors in which the metal case is one of the plates, in which event it is most important that the capacitor is mounted in such a way that no danger to property or self is involved. We suggest that it should be fixed to a substantial paxolin panel, with a paxolin cover over the fixing screws should these project on the outside of the chassis where they could be handled. Wiring, too, should be carried out in high-quality sleeving, and for this purpose sleeving which has a polythene or similar inner tubing is ideal.

On the primary side of the EHT supply, the winding L1 is fitted with a fuse and a switch in each of the leads. This is done, not in order to use as many components as possible, but in order to afford some protection to the transformer in the event of trouble arising in the tube supply circuit, and what is even more important, to make sure that the circuit really IS disconnected from the mains when " switched off." Switches should be of the quick-action toggle type, and the fuses should be rated at 1A.

Before finally leaving this section, one or two *points on the mechanical* side call for mention. A clear picture WILL NOT be obtained unless it is possible to get a small, sharply defined " spot " on the screen when the tube is tested with its network and supplies. As far as the EHT supply is concerned, this means that the voltage must not be too low—we recommend 1,500 volts as the minimum—and that the spot is not distorted through being affected by the magnetic field surrounding the EHT transformer. Both tubes are fitted with a mu-metal screen to minimise the latter effect, but even so the transformer should be carefully located. As previously mentioned, the 5CP1 is the more touchy of the two, and the EHT supply for this is best mounted on a small chassis so that it may be located easily in the most convenient position—it may need to be as much as three feet from the tube! The VRC97 is not so critical, and it was found possible to mount the transformer behind a screen and just below the tube holder without ill-effect.

The rectifier valveholders should be either ceramic, or the bakelite holders with a long leakage path which are specially made for the purpose. Resistors should preferably be one watt, as these are fairly long and not so liable to " flash-over " as the half-watt type, and should be firmly mounted, preferably on a mounting strip or panel.

Next instalment: Tubes, tube network, and time-base power supply unit.

(*THERMIONIC VALVES—continued from page* 365).

Subsequent cycles of applied voltage will reduce Va until a steady state is reached where only the tips of the positive half-cycles recharge C, maintaining a current flow through R.

Thus, through R flows a steady DC and across R is a steady potential difference (PD).

When a modulated input is applied to the diode circuit, the DC through R will rise and fall at modulation frequency so that across the RC combination the following are developed :—

1. DC Voltage—due to current flow.
2. RF Voltage—due to signal input.
3. AF Voltage—as mean value of PD across

   R is now varying at AF due to modulation.

See Fig. 19.

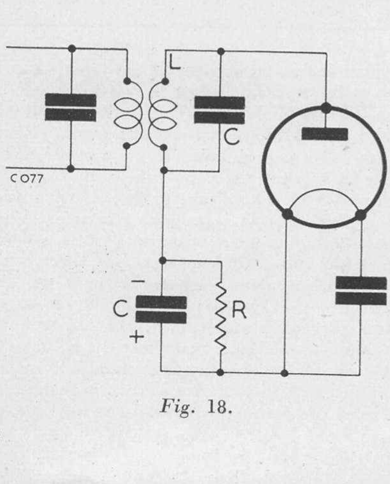


Fig. 18.

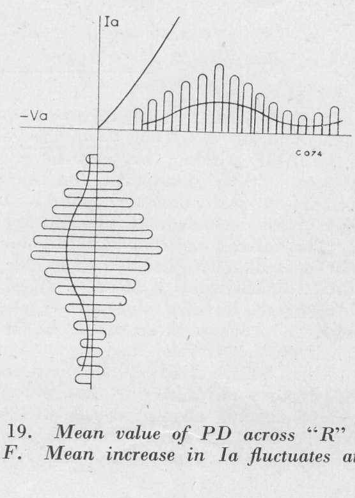


Fig. 19. Mean value of PD across "R" varies at RF. Mean increase in Ia fluctuates at AF.

Radio Simplified

By A. J. Duley

Part 5

IN the last two articles, the expressions " straight " and " superhet " have occurred. Let us see the fundamental differences between these types of circuit.

The Straight Circuit.

In this type of set, the signal comes in via the aerial lead in, and is fed to the tuning circuit, the action of which is to select one particular frequency. This circuit can take many forms, the commonest being the coil and capacitor circuit as shown in Fig. 1.

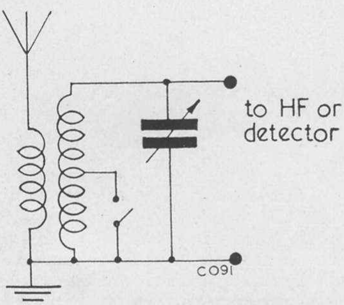


Fig. 1. Usual method of tuning. Frequency is varied by capacitor.

This frequency is fed to the grid of the valve, either for rectification, or demodulation as it is called, or for amplification as an HF signal. The whole point is that the signal itself, or an amplified version of it is first rectified and then amplified by the audio frequency side of the set.

If, however, the signal received is say 1,000 kilocycles, and a valve oscillator generates a signal of 1,465 kcs., and we combine the two signals in some way, then it would be possible to extract signals at 465 kcs., and also at 2,465 kcs., the sum and difference of the two original signals.

In superheterodyne receivers, this principle is used, and 465 kcs. is the commonest frequency difference, although various other frequencies are in use, such as 110 kcs., 450 kcs. and 1,600 kcs. The local oscillation can be generated by a separate valve, or can be supplied by a valve with a dual function. Valves of the pentagrid and triode-hexode types are in this class. A circuit showing the two valve type of circuit is in Fig. 2, using an HF pentode as the " mixer " and a triode as an oscillator. In the anode circuit of the HF pentode the device for extracting the required frequency is connected. This consists of an intermediate frequency transformer which is tuned to the intermediate frequency, and for the final adjustment of this, a small trimming capacitor is usually connected across the transformer winding, and " lining up " as it is called, is done with the aid of these.

The circuits for pentagrid and triode-hexode valves are shown in Figs. 3 and 4. The signal circuit is shown in dark lines, and the oscillator in lighter lines. In the case of the triode-hexode, the triode oscillator part is clearly seen. The pentagrid consists of a triode section for an oscillator, and a screen grid valve for the mixer section. Both these valves use a common cathode and this is the electrode which causes the mixing of the signal and oscillator frequencies. This

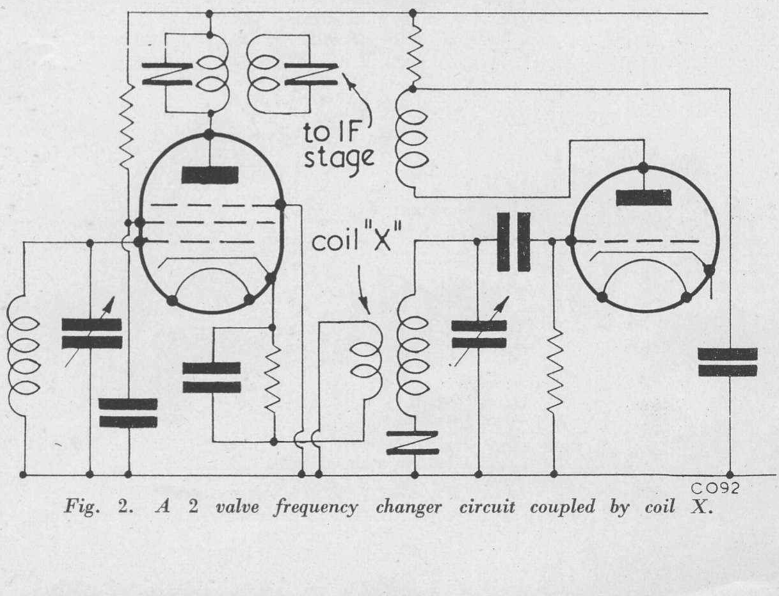


Fig. 2. A 2 valve frequency changer circuit coupled by coil X.

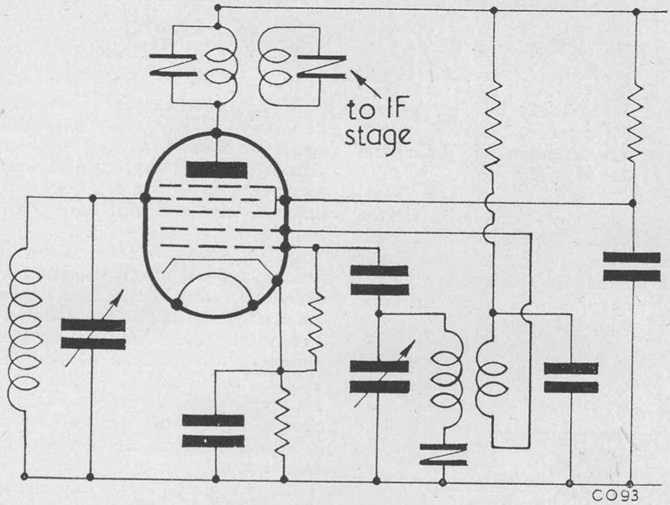


Fig. 3. Pentagrid or Heptode circuit.

also is the case in the triode-hexode, and other types of multi-electrode valves such as the octodes, which have good performance on short waves.

On explaining this principle to my Pet Nephew, he raised the objection that the straight circuit seemed to do the job a darned sight quicker, and without the bother of juggling around with frequencies and that he was blowed if he could see what advantage was to be gained from using this system. Cursing him heartily at his impatience, I proceeded to iron out his difficulties.

From the " frequency changing " stage with which we have just dealt, the " intermediate frequency " is extracted by the IF transformer, and passed on to a normal type of HF amplifier. Here lies the point of the superhet design.

On a normal radio set, the medium waveband goes from 1,250 kcs. to 500 kcs. (250-600 metres) and all HF amplifiers have to cope with this variation in frequency. In the superhet, the oscillator and the signal frequencies are ganged in such a way that the intermediate frequency is fixed at some prearranged value, and consequently the HF amplifier can be built to amplify at the one frequency, thus the amplifier after the frequency changer stage is called " intermediate frequency amplifier." Fig. 5 shows a frequency changer stage followed by an intermediate amplifier stage. The output from the secondary of the IF transformer may go to another IF amplifier stage, or to the rectification stage. This may take several forms, for instance, an ordinary " leaky grid," or " anode bend " detector, as used in normal " straight " sets

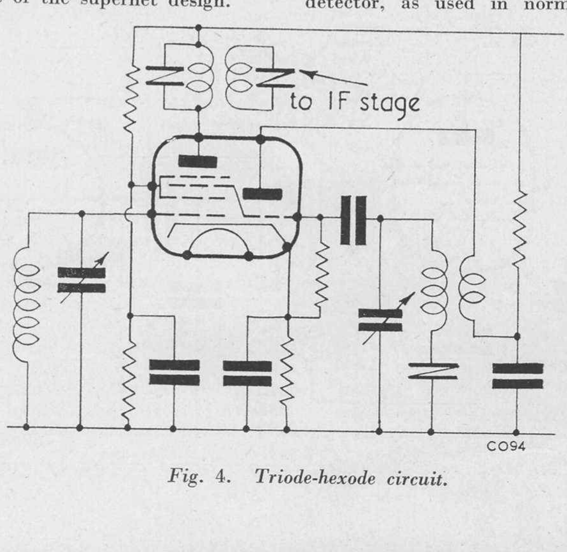


Fig. 4. Triode-hexode circuit.

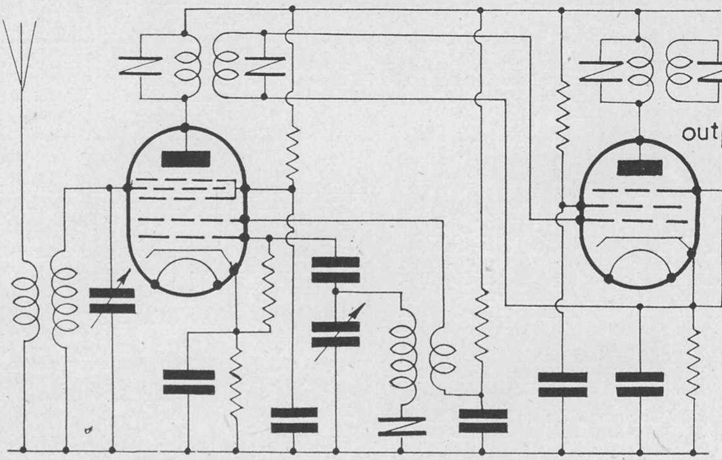


Fig. 5. FC and IF stages.
(The secondary winding of the IF transformer should be returned to the negative line and not to cathode as shown.)

may be used, but more likely is the use of a valve combining rectification and LF amplification, such a valve as the diode-triode, or diode-pentode, the circuit of which is given in Fig. 6. The secondary of the IF transformer, shown in Fig. 6, is the secondary shown unconnected in Fig. 5. This is now connected across the diode section of the diode-pentode, and thus the signals in the secondary are rectified, and are applied to the control grid of the pentode via the diode load as shown.

My P.N. then raised the point that the addition as well as the difference may cause a signal in the set ; this I contradicted, as the IF transformer will eliminate this trouble, but a common trouble is that caused as follows : if the signal is 1,000 kcs. and the IF is 465 kcs., the oscillator will be oscillating at 1,465 kcs. Now, if there is a station at 1,930 kcs. this is also 465 kcs. from the oscillator and will also be picked out by the IF transformer. This is known as "second channel" interference, and on the suppression of this fault, the choice of the IF itself lies. A low IF is good for selectivity, but a higher frequency is needed for suppressing second channel interference.

To eliminate this fault, a system of double frequency changing was introduced, in this type of circuit, a first change of frequency to a region of megacycles eliminated second channel interference and the second change to the region of a few kilocycles (110 kcs., for example) made the selectivity good again.

Work on the ultra short range (60 megacycles) has produced an IF as high as 4 megacycles, for at this frequency, the selectivity does not necessarily have to be of a high order.

Other types of tuning, such as variable permeability tuning (the insertion of iron dust cored plungers into coils), have been introduced into the superhet receiver. The push-button systems involve either a set of fixed capacitors (or rather semi-variables switched in by each button) or the buttons control an electric motor which rotates a capacitor or varies iron dust cored plungers in order to tune the circuit.

For high selectivity, crystal filters are introduced into the IF circuits in a similar capacity to those as used in a transmitter—that is for frequency control.

It will be found that no matter how scientifically oscillator and mixer circuits are designed, true ganging is impossible to obtain. In this respect, a trimmer is connected in each circuit. Certain points are taken to be absolutely true for ganging and from these the circuit is modified by adjusting the trimmers.

In the next instalment, it is proposed to tackle the subject of bridges and their uses. This will be followed by notes on the cathode ray tube.

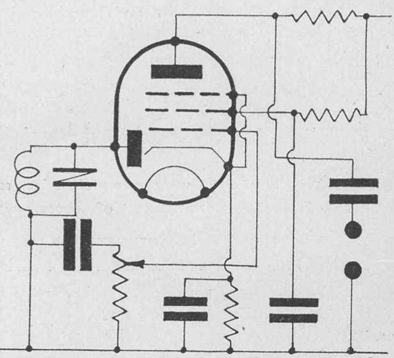


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Fig. 6. Diode-pentode for detection and amplification.

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